TECHNICAL NOTES

WIND EROSION EQUATION
USE OF MICROSOFT EXCEL SPREADSHEET

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- **Purpose** This note will give the background and basic instructions to use the Wind Erosion Equation (WEQ) Microsoft Excel spreadsheet computer version. To operate the equation the user will need to have a good understanding of Part 502 of the National Agronomy Manual. User will need a computer with at least a 486/33 or better (586 is better); Windows, 95, 98; or NT, MS Excel version 7.0 or better; 64 meg of RAM or better; a copy of the spreadsheet (**WEQv8.01.xls**) from the following web site:
  http://www.nm.nrcs.usda.gov/Techserv/TechNotes/agro/ag55.xls.

- **Background** In the late 1980s a computer version of WEQ was developed for the UNIX based 3b2 commuters. It allowed us to run a management period method calculation in a fraction of the time a long hand version could be done. We have used this version until recently. Circular No. 2 (amendment to the NAM) came out Sept. 12, 1997. It **added** an adjustment for irrigated fields (Lowering the I for irrigated fields and reducing Erosive Wind Energy (EWE) for surface wetness), an adjustment for random roughness (RR), and a way to interpolate the Climate (C) factors. When this happened we were unable to use the new WEQ module in FOCS. FOCS was not able to compute the Circular No. 2 changes, and no one will be doing this in FOCS in the future. In about 2 years we will be going to a windows based computing system, the Wind Erosion Prediction System (WEPS). **WEQvs8.01xls was created to fill the two-year gap and incorporate Circular 2 changes**.

- **General –** The WEQ management period method spreadsheet can be in states that use the management period method to estimate wind erosion.

  To operate the equation the user will need to have a good understanding of Part 502 of the National Agronomy Manual (NAM). Planners will be able to use this spreadsheet, **if they have a basic understanding of the wind erosion equation, can do a residue reduction calculation, understand irrigation (where the land is irrigated), and have basic Excel spreadsheet skills**. The State Agronomist will need to set up the wind climate data, crop data and operation (tillage) files. Cropping systems developed on the model (WEQ Input Worksheet) can be saved to a file and used as templates for future use by the client or for new planning. The light yellow shaded areas are the **only** "user" data required to run the program. The worksheet is "protected". This is not because the user is not trustworthy; it is because some of the data should only be changed state wide, and mostly because if a formula is lost it can be very difficult to replace.

- **Irrigated Circles -** Many irrigation circles in are planted in a circular pattern. To estimate wind erosion on fields planted and/or tilled in a circular pattern, two estimates need to be made. The first estimate should be made after selecting a NS tillage direction and the second should be an EW direction. The average of the two estimates is the correct soil loss value. In the example it does not make a difference, but when making other erosion estimates on circular tilled fields this averaging procedure should be completed.

- **Definitions -** The first sheet in the spreadsheet (**Instr**) has most of the column headings defined and an explanation of the information required for the spreadsheet to run. Please print a blank worksheet (**Res Wks**) and the calculation sheet (**Calc**) before reading the **Instr** sheet. **Remember only the shaded area cells need input data.** Please read the **Instr** sheet before starting.

- **Circular Reference Bug -** There is a circular reference bug in the sheet. As you enter data for the first time you will find an error caution will come up and tell you there is a circular formula error in the sheet. **DO NOT PANIC** and call for help! Just close the warning box when it pops up and continue to add the data needed for the run. The error warning will stop when the first harvest is entered.

Step by Step

This is a step by step process to show how to use the program. Start the step by step process after reading the **Instr** sheet (the tab at the bottom of the WEQ Excel spreadsheet).

Step 1 - Fill in the **Producer**, **Planner**, **Location** (Farm Unit or Sec., Town., Range), **Tract**, **Field**, and **Crop Rotation** boxes.

Step 2 - Use the drop down menu to select the **Climate Data Station**. The climate data is pulled from the **Climate** sheet (see the tab at the bottom of the worksheet).

Step 3 - Fill in the **C Value** (in whole numbers. Divide the isobar interval only once from the C factor map)**, Field Width** of short side of field (ft)**, Tillage Direct.** (EW or NS, drop down)**, Length/Width Ratio** (number equal to or greater than one, drop down), **Field Direction** (EW or NS, drop down)**, Irrigation** (Y/N, pull down)**,** and **Soil "I"** (drop down).

Step 4 - Determine the **Wind Erodibility Group** (WEG) from the FOTG soil survey, and fill in the number (1-7 or 4L, drop down).

Step 5 - Place **1/1/xxxx** on the first line of worksheet (next to Start Rotation). Start the first management period on January 2, (current year) with an **Over winter loss** operation. Go to the **Operation Date** column on row 13. Put in the date **1/2/xxxx**. Next place the cursor in the **Crop** column next to the date, left click in the box to activate the pull down and select the previous crop harvested (select from the list). Move to the **Operation** column. In cell C13, click the pull-down and select the **Over winter loss, fragile (F) or non-fragile (N) operation** (see NAM Part 503 Subpart E, table 1 & 2, for definition), repeat these steps with correct dates until all tillage operations, planting operations, and harvests are completed. As you select the planting operation change the crop to the new crop beginning with the planting operation.

Step 6 - The next date after planting will be the end of the first 15-day growth period. The date can be entered as a formula. In the blank date column A, type **=**, then point and click on the cell just above, then type **+15**, then hit the return key. This will enter a formula that tells the computer, to type the date above and add 15 days. All growth periods are 15 days except winter wheat or other winter crops, which have a 60-day growth period over winter (see the **Crop** table for details).

The 15-day date formula can be copied down for the number of growth periods for the crop planted. Next, in the **Crop** column click and select the growing crop name with a number **(15 to 75)** next to it. Continue to select down the column a series of growth periods. Example: **Bean 15**, **Bean 30**, **Bean 45**, **Bean 60**, and **Bean 75** can be copied and moved at the same time to the **Crop Name** column of the **Res Wks**. This must be done using the **paste special** function. Select the Crop Tab and find the correct series of grow names, highlight them and copy them. Change back to the **Res Wks** sheet, place the cursor in the first cell under **Crop** (column B) where crop growth begins, right click and click on **paste special**, then select the radio button for **value** under the paste section, and click OK. In the **Operation** column enter (click and select) **"Grow"** for all the growth periods. **"Grow"** can be pasted in the first cell for "Grow" and then copied down the sheet (**Res Wks**) as needed**.** All growth series of data can be copy from the tables in groups and **paste special** used to paste only the **values** to the **Res Wks**. If you copy and paste normal you will lose the formatting in the cells.

Step 7 - Enter the **Harvest date**, the harvested **crop name** (without a number extension), and the word "**Harvest**" for above ground crops or "**Harvest, root crop**" for root crops in the **operation column**.

Step 8 - Enter the **date** of any post harvest tillage**, crop name** (residue just harvested), and the name of the **operation.** Repeat step 5, 6, 7, and 8 for any additional crops in the rotation. 100 management periods can be used in each calculation. If more are needed try removing lines where there is no erosion. An example would be to reduce the number of operations of **"Grow"** to just what is needed to take erosion to zero for the rest of crop growth period.

Step 9 - End the run with a **12/31/xxxx date,** last harvested **crop name**, and the **End Rotation** operation.

Step 10 - Enter any **irrigations** for the periods listed. Enter the **number** of irrigations in each period (This is NOT the cumulative number of irrigations). Keep in mind the stage of growth and the consumptive use of the crop during the management period. See table 1.

Step 11 – In the **Flat Res.** column on each line of the run enter **0** when residue is 100% standing (no flat residue), and 100 when all the residue is flat (as in heavy inversion tillage). Example, if 60% of the residue is standing after a tillage, then enter 40 or 0.4 and hit the return key. The number will be in percent.

Step 12 - Finally, adjust any **yield values** that are different than the default yields in column G-H. You can change the yield by 50% up or down by using the drop down in the **Yield Adjustment** column (F).

Example

- Iam Windy farms, tract 123 on an irrigated circle (field 1) of continuous grain corn, where the soil has an I of 56. The circle field has a diameter of 2640 ft, and is near Clovis, NM. The C is 100. The grower tills and/or plants approximately perpendicular to the damaging winds from the west during the spring critical period. The field is farmed north and south. Iam plants corn on 4/15 and harvests 10/15. The stalks are disked with an offset disk and packer on 11/1. In the spring the field is disked and packed again on 3/15. On 4/1 the circle is moldboard plowed, conventionally and packed. Then, on 4/10 a seedbed maker is used to set up the field for the corn planter. The corn is cultivated on 5/15. His average yield has been 200 bushels/acre.

Step 1 - Fill in: **Iam Windy**, **MAS**, **Clovis, NM**, tract **123**, field **1**, and **Corn, grain** in the rotation box.

Step 2 - Select the climate data station of **Clovis, NM** from the pull down list.

Step 3 - Put **100** in the C box, **2640** feet in the width box, **NS** for tillage direction, length width ratio is **1.0**, field direction is **EW**, Irrigation is **Y**, and soil I is **56**.

Step 4 - WEG is **5**.

Step 5 - Enter **1/1/1999** in the first line (cell A13) of the table, and select (cell B13) **Corn, grain, high yield** from the **Crop** table drop-down list. Enter **1/2/1999**, copy **Corn, grain, high yield** from the above cell to row 14 in the crop column, select **Over winter loss N** in the **operation** column. Enter the first tillage on **3/15/1999**, copy **Corn, grain, high yield** from the cell above, select **Disk, offset, heavy N** from the **Oper** drop down list. Do the same for the **Packer, roller** on the same date**.** Enter **4/1/1999** and put in the **Plow, moldboard, conventional** and **Packer, roller.** Enter **4/10/1999** and copy **Corn, grain, high yield**. There is no seedbed maker operation, but a **Chisel-disk-harrow-packer (comb) N** is close, so use it. Enter **4/15/1999**, **Corn, grain, high yield** and **Planter, DD opener, 30 in sp N**.

Step 6 - Copy the 4/15 date and add 15 days to the formula. Copy or select **Corn, grain 15** through **Corn, grain 75** from the **Crop** table to the crop column. Type or select **Grow** in the **Operation** column and copy down to match the **Crop** column. Copy down the **Operation Date** column to match the growth cells. Note that there is a cultivation on the second growth date. Copy the six columns of data from 5/15 down one line to add the cultivation. On the second 5/15 date in the **Operation** column copy and paste or select the **Cultivator, rowcrop, 3 in ridge** operation.

Step 7 - Enter the harvest date **10/15/1999**, copy down the crop **Corn, grain, high yield** and type or select the word **Harvest**.

Step 8 - Add the post harvest tillage on **11/1/1999**. Copy both tillage operations from the cells above.

Step 9 - End the run by entering **12/31/1999**, copy **Corn, grain, high yield** and copy or select the **End Rotation** operation.

Step 10 - In the NM FOTG, sec I, in the Irrigation Guide we find that the Consumptive Use (CU) irrigation requirement for **Corn, grain** is 32.4 inches of water per year. We also know that peak daily CU is about 0.30 inches for Corn (by dividing the highest month by 30). Most circle systems are set up to meet the peak CU. We can estimate the number of irrigations needed for each growth period or use Iam's records for each period. To estimate divide the 32.4 in. by 0.30 in/day and we find we need 108 irrigation days. See Table 1 for the number or irrigation per month estimated.

Table 1 Consumptive Use for Corn at Clovis NM

		Corn Irrigation Water Use at Clovis, NM			
Month (mo)	Month by period (date)	Consumptive Use/Month (in/mo)	Consumptive Use/Day (in/day)	Number of Irrigaitons/ Month (number/mo)	Number of irrigations/Mgt period (number)
April	4/10 to 4/15	1.5	0.05	5	2
	4/15 to 4/30				3
May	4/30 to 5/15	3.3	0.11	11	5
	5/15 to 5/30				6
June	5/30 to 6/14	6.6	0.22	22	11
	6/14 to 6/29				11
July	7/1 to 10/15	8.7	0.29	29	70
August		7.5	0.25	25	
September		4.8	0.16	16	
October		0	0	0	
					Total 108

The number of irrigation per month can then be entered by each growth period. Estimate 2 irrigations for preplant, 2 in the first period, 3 in the second, 5 in the third, 6 in the fourth, 11 in the fifth, 11 in sixth and 70 in the last (the remaining of the year). Leave the period just before the cultivation blank since both operations occur on the same day.

Step 11 - Go down the **Flat Res** column and estimate the **percent flat residue**. Start on the Harvest Operation. Estimate about 50% of the residue is standing after harvest and 0% is standing after the fall tillage. Enter **50** at the harvest, and 100 in the management period after the fall packing. Note only the 1st period after harvest has standing residue.

Step 12 – Select **.5** on the drop down in column F. This increases the 135 bu/ac to 200 bu/ac.

See the attached example.

NRCS - WEQ INPUT WORKSHEET, Version 8.01

Producer: Iam Windy Farms	**Climate Data Station:** NM, CLOVIS	**Tract:** 123 **Field:** 1
Planner: Cropland Student	**Field Width** (Ft.): 2640 **Tillage Direct** (NS/EW): NS	**Irrigated?** (y or n): Y
Crop Rot: Corn, grain	**Field Direction** (NS/EW): EW **Length/Width Ratio:** 1.0	**Wind Erodibility Group:** 5 (1-7)
Location: Covis, NM	**Adjusted Soil "I":** 56 **Site "C" Value:** 100	

Average Annual Wind Erosion (t/ac): 6.9	**Yrs in Rotation:** 1.0	**Sum Period Erosion:** 6.9 (tons/ac)

Crop and Operation Management Records/Residue Calculations (green and dry)

Operation Date (date)	Crop (name)	Operation (name)	No. of Irr./Period (#)	Flat Res. (%)	Yield Adjustment (%)	Yield (units/ac)	Ridge Height (in)	Ridge Spacing (in)	Est. Res Retention (fact)	Est. Res. Dry Matter (lb/ac)	Est. Ground Cover (%)	SGe Dry Residue (lb/ac)	Green Dry Matter (lb/ac)	SGe Green Growth (lb/ac)	Random Roughness (in)
1/1/99	-	Start Rotation		100%		- - -	0	0	0.90	3184	66	1564	0	0	0.30
1/2/99	Corn, grain, high yield	Over winter loss N		100%			0	0	0.80	2547	58	1236	0	0	0.30
3/15/99	Corn, grain, high yield	Disk, offset, heavy N		100%			1	11	0.30	764	24	346	0	0	0.50
3/15/99	Corn, grain, high yield	Packer, roller		100%			0	0	0.95	726	23	328	0	0	0.30
4/1/99	Corn, grain, high yield	Plow, moldboard, conventional		100%			1	18	0.02	15	1	5	0	0	1.00
4/1/99	Corn, grain, high yield	Packer, roller		100%			0	0	0.95	14	1	5	0	0	0.30
4/10/99	Corn, grain, high yield	Chisel-disk-harrow-packer (comb) N	2	100%			1	30	0.45	6	1	2	0	0	0.50
4/15/99	Corn, grain, high yield	Planter, DD opener, 30 in sp N	3	100%			1	30	0.85	5	1	2	0	0	0.40
4/30/99	Corn, grain 15	Grow	5	100%			1	30	1.00	5	1	2	1	7	0.40
5/15/99	Corn, grain 30	Grow	0	100%			1	30	1.00	5	1	2	150	569	0.40
5/15/99	Corn, grain 30	Cultivator, rowcrop, 3 in ridge	6	100%			3	30	0.70	4	1	2	150	571	0.60
5/30/99	Corn, grain 45	Grow	11	100%			3	30	1.00	4	1	2	500	1482	0.60
6/14/99	Corn, grain 60	Grow	11	100%			3	30	1.00	4	1	2	2500	5286	0.60
6/29/99	Corn, grain 75	Grow	28	100%			3	30	1.00	4	1	2	4000	7662	0.60
10/15/99	Corn, grain, high yield	Harvest		0%	50%	200 bu/ac	3	30	1.00	11172	100	8475	0	0	0.60
11/1/99	Corn, grain, high yield	Disk, offset, heavy N		50%			1	11	0.30	3352	68	2094	0	0	0.50
11/1/99	Corn, grain, high yield	Packer, roller		100%			0	0	0.95	3184	66	1564	0	0	0.30
12/31/99	Corn, grain, high yield	End Rotation		100%			0	0	1.00	3184	66	1564	0	0	0.30

NRCS - WEQ CALCULATIONS, Version 8.01

Producer: Iam Windy Farms	**Planner:** Cropland Student	**Location:** Covis, NM	**Tract:** 123	**Field:** 1
Crop Rotation: Corn, grain	**Climate Data Station:** NM, CLOVIS			**Site "C" Value:** 100
Tillage Direction (NS/EW): NS	**Length/width ratio:** 1	**Field Direction** (NS/EW): EW		**Field Width** (Ft.): 2640
Irrigation (Y or N): Y	**Soil "I":** 56	**Wind Erodibility Group:** 5 (1-7)		**TWF:** 2 (see instr.)
Sum Period Erosion (t/ac): 6.9	**No. Yrs in Rotation:** 1.0	**Av. Annual Wind Erosion:** 6.9 (t/ac/yr)		

Calculations and Output

Mgt Periods		Irr.	Soil	Ridge Roughness				Random Roughness	Unsheltered Distance				SGe	Erosion			
Dates		No. of	"I"	Dev.	Ht.	Sp.	"Krd"	"Krr"	Dev.	Prep.	WED	"L"	"V"	"E"	EWE	"IF"	Loss
Begin	End	(#)	(t/ac)	(deg)	(in.)	(in.)	(factor)	(factor)	(deg)	(factor)	(factor)	(ft)	(lbs/ac)	(t/ac)	(%)	(%)	(t/ac)
1/1	01/02/99	0	38	0.0	0	0	1.00	0.86	90.0	2.1	1.020	2693	1564	0.8	0.3	1.00	0.00
1/2	03/15/99	0	38	0.0	0	0	1.00	0.99	90.0	2.1	1.020	2693	1236	3.6	27.7	1.00	1.01
3/15	03/15/99	0	38	22.5	1	11	0.93	0.58	67.5	1.8	1.030	2719	346	11.7	0.0	1.00	0.00
3/15	04/01/99	0	38	22.5	0	0	1.00	0.99	67.5	1.8	1.030	2719	328	25.9	10.8	1.00	2.80
4/1	04/01/99	0	38	22.5	1	18	0.86	0.33	67.5	1.8	1.030	2719	5	7.6	0.0	1.00	0.00
4/1	04/10/99	0	38	22.5	0	0	1.00	0.86	67.5	1.8	1.030	2719	5	28.4	5.0	1.00	1.42
4/10	04/15/99	2	38	22.5	1	30	0.90	0.58	67.5	1.8	1.030	2719	2	15.5	2.8	0.20	0.09
4/15	04/30/99	3	38	22.5	1	30	0.90	0.69	67.5	1.8	1.030	2719	2	19.2	8.3	0.60	0.96
4/30	05/15/99	5	38	22.5	1	30	0.90	0.69	67.5	1.8	1.030	2719	9	19.1	5.9	0.33	0.38
5/15	05/15/99	0	38	45.0	1	30	0.91	0.69	45.0	1.8	1.030	2719	572	10.3	0.0	1.00	0.00
5/15	05/30/99	6	38	45.0	3	30	0.63	0.50	45.0	1.8	1.030	2719	572	4.0	5.7	0.20	0.05
5/30	06/14/99	11	38	45.0	3	30	0.63	0.50	45.0	1.8	1.030	2719	1483	0.0	3.6	0.00	0.00
6/14	06/29/99	11	38	67.5	3	30	0.68	0.50	22.5	1.8	1.030	2719	5288	0.0	3.3	0.00	0.00
6/29	10/15/99	28	38	67.5	3	30	0.68	0.86	22.5	1.8	1.030	2719	6999	0.0	7.4	0.48	0.00
10/15	11/01/99	0	38	67.5	3	30	0.66	0.86	22.5	2.5	1.060	2798	6999	0.0	2.9	1.00	0.00
11/1	11/01/99	0	38	45.0	1	11	0.93	0.58	45.0	1.5	1.030	2719	2094	0.0	0.0	1.00	0.00
11/1	12/31/99	0	38	45.0	0	0	1.00	0.99	45.0	1.5	1.030	2719	1564	1.1	16.1	1.00	0.18